SST 91-92

SUMMER STIPENDS
1991-1992 Academic Year
Application Cover Sheet

PATSY RECORD # _____

Project title: Predicting Academic Performance: Multiple Regression Vs. Neural Networks

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Category *Please check all descriptions that apply, so as to ensure that your application is given full consideration in all competitions for which it may be eligible.*

1. Are you a member of the:
   - X School of Business
   - ___ School of Law
   - ___ School of Nursing

2. Does your project fall within the humanities? _____

3. At the University level, do you believe your application should be reviewed with other projects in
   - ___ humanities and fine arts
   - ___ physical and mathematical sciences
   - X social sciences

   {IF SELECTING MORE THAN ONE, PLEASE INDICATE FIRST AND SECOND CHOICE CLEARLY}

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Abstract Please limit your abstract to the space provided below. Do not photoreduce your material.

The traditional approach to predicting academic performance has utilized multiple correlation and regression methods with modest success. This study will contrast the effectiveness of neural networks and multiple regression identifying students who will do well academically.

PREDICTING ACADEMIC PERFORMANCE: MULTIPLE REGRESSION VS. NEURAL NETWORKS

The methods of multiple correlation and regression analysis are frequently used in formulating predictions of student performance, both at the graduate and undergraduate level. Studies have indicated that regression equations function moderately well and can aid the admissions committee to resolve cases with conflicting applicant information. Multiple variables are preferred.

Though a popular approach, correlation and linear regression have not yielded high predictive accuracy. Pitcher and Smith obtained an average multiple correlation of .43 in predicting the first year grade point average from undergraduate record and the Graduate Management Admissions Test (GMAT) scores. In a study of fourteen graduate schools of business, Pitcher and Schrader reported an average multiple correlation of .44 using undergraduate GPA, and GMAT verbal and quantitative scores as independent variables.

Burnham and Hewitt reported a multiple correlation of .51 between College Board Scores, high school average, and achievement in college. Schwartz and Clark, in a study of graduate success at Rutgers University, found a multiple correlation of .43 between graduate averages and undergraduate grade point averages, the Miller Analogies Test and the Doppelt Mathematical Reasoning Test.

Abedi, using correlation techniques, found undergraduate GPA not to be a good predictor of graduate academic success. Schurr concluded that SAT scores are a poor predictor of freshman GPA using multiple regression. Beaulieu using both correlation and regression, to predict quantitative business course grades based on a battery of aptitude and personality tests found that performance could be predicted for men by aptitude, but not for women. Bridgeman calculated correlations of SAT scores and high school rank with freshman GPA and got results between .26 and .40. Young, using regression to predict freshman year GPAs at Stanford found that only 33% of the variance was explained by the predictors SAT scores and high school GPAs. So the results have been far from satisfying when using correlation and regression techniques to predict student academic performance.

Neural networks are a technique of classification and pattern recognition that has been used with success in diverse areas. One of the strengths of a neural network is its ability to construct a whole pattern from partial information. The computed pattern will be the best fit (in the least squares sense) to the partial pattern. This statistical pattern recognition ability enables the neural network to construct patterns where the input data may be incomplete, ambigious or inexact. Stoisits, in support of neural networks capabilities, believes that in the future they will be more widespread than numerical analysis tools.

Halbert White has compared neural networks and statistical methods and concludes that back propagation (a type of neural

network) and nonlinear statistical regression are alternative statistical approaches to the least squares problem. Some special cases of pattern recognition in which neural networks have been successful are prediction of commercial bank failures (Eliot), analyzing quality control im manufacturing (DARPA), appraisal of mortgage applications (Pollack), submarine identification (Gorman and Sejnowski), optimizing traffic routing in communications networks (Rauch), and optimizing patient process decisions by critical care physicians (Stubbs). Many of these problems deal with predicting the outcome of future events. But the neural network views them, not as future events, but simply as a pattern it is trying to recognize and fit.

Neural networks, because of their ability to discern patterns where data is imperfect, might be able to classify or categorize students more accurately than traditional correlation and regression techniques have been able to do. It is the purpose of this study to compare the two techniques in their ability to distinguish between students who perform well academically and those who do not, based on information available prior to admittance. A sample of business school graduates would be chosen and data would be collected on the following attributes: overall GPA, business GPA, high school GPA, SAT or ACT scores, type of high school attended (private religious, private non-religious, public) sex, major, age, and high school class ranking. The college GPAs would be used as the dependent variables in multiple regression equations and as the output variables in a neural network. The remaining variables would be

independent variables in the regression equations and input variables to the first layer in a neural network. Results from the methods will be compared to see whether the neural network technique can improve our ability to identify which students will perform best in business schools.

BIBLIOGRAPHY

Adedi, J. "Predicting Graduate Academic Success from Undergraduate Anademic Performance: A Canonical Correlation Study." Educational and Psychological Measurement, 1991, 51, pp. 151-160.

Beaulieu, R.P. "A Course Specific Perspective in the Prediction of Academic Success." Psychology, 1990, 27(No. 1) pp. 21-26.

Burnham, P. S. & Hewitt, B. A. "Secondary School Grades and Other Data as Predictors of Academic Achievement in College." College and University, 1972, 48, 21-22.

Bridgeman, Brent. "Essays and Multiple-Choice Tests as Predictors of College Freshman GPA." Paper read at American Educational Research Association, Boston, April 1990, 22 pp.

DARPA Neural Network Study, AFCEA International Press, 1988 (November), pp. 411-413.

Eliot, Lance, "Business Applications: You Can Bank On It," Neural Network News, 1989, 1 (No. 4), p. 1.

Gorman, R. P, and T. J. Sejnowski, "Analysis of Hidden Units in a Layered Network Trained to Classify Sonar Targets," Neural Networks, 1988, 1 (No. 1), pp, 75-89.

Pitcher, B. & Schrader, W. B. "Indicators of college quality as predictors of success in graduate schools of business." Princeton, M. J.: Educational Testing Service, Brief Number 6, 1972.

Pitcher, B. & Smith, J. "Moderator variable study: the effect of background factors on the prediction of performance in graduate business school." Princeton, J. J.: Educational Testing Service, Brief Number 3, 1969.

Pollack, Andrew, "More Human Than Ever, Computer is Learning to Learn," New York Times, September 15, 1987, section C, p. 2.

Rauch, Herbert & T. Winarske, "Neural Networks for Routing Communication Traffic." IEEE Control Systems Magazine, 1988, 8 (April), pp. 26-31.

Schurr, K. T. et al, "The Use of the College Board Classification of High Schools in Predicting College Freshman Grades." Educational and Psychological Measurement, 1990, 50 (Spring), pp. 219-223.

Schwartz, M. J. & Clark, F. E. "Prediction of Success in Graduate School at Rutgers University." Journal of Educational Research, 1959, 53, pp. 109-111.

Stoisits, R. F. "AI is Vital Part of Production Computing," Oil & Gas Journal, January 9, 1989, 87 (No. 2), p. 48.

Stubbs, Derek, "Neurocomputers," M. D. Computing, 1988, 5 (No. 3), pp. 14-24.

White, Halbert. "Neural-Network Learning and Statistics." AI Expert, 1989, 4 (No. 12), pp. 48-52.

Young, John W. "Are Validity Coefficients Understated Due to Correctable Defects in the GPA?" Research in Higher Education, 1990, 31(August) pp. 319-325.

Publication Plans

Upon completion of this study, it will be submitted to one of the following refereed journals: Neural Networks, Computers and Education, Journal of Education and Business, International Business Schools Computer Users Group

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"Computer Education and Computer Related Professions of the Future", Journal of Applied Business Research, Volume 2, Winter 1985-86, pp. 27-34, co-authored with Glen Emerson.

"Projected Federal Government Computer Personnel Needs: Results of a Survey", Journal of Applied Business Research, Volume 3, Spring, 1986, pp. 28-38, co-authored with Glen Emerson.

RESEARCH IN PROGRESS: Projected Federal Government Computer Personnel Needs: 5-Year Update

Predictors of Student Performance in Graduate Schools of Business: A Multiple Regression Residuals Analysis

MIS Personnel Recruiting During Economic Recession: An Inventory of Hiring Practices Among Major Oklahoma Companies, 1985-1989

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